

2001 UPDATE

**ASSEMBLY BILL 970  
DRAFT  
RESIDENTIAL BUILDING  
ENERGY EFFICIENCY  
STANDARDS**

**CONTRACTOR'S REPORT**

VOLUME 1 - SUMMARY

November 2000  
P400-00-023/ V1



Gray Davis, Governor

# CALIFORNIA ENERGY COMMISSION

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Assembly Bill 970 Building Energy Efficiency Standards**

**Contractor Report**

**2001 Update – AB 970 Draft Residential  
Building Standards**

**Energy Commission Publication No. P 400-00-023/V1  
Summary**

This Contractor Report, prepared by Berkeley Solar Group, Enercomp, Inc., Proctor Engineering and Modera Consulting Engineers, summarizes the proposed changes to the Residential Building Energy Efficiency Standards. This report is intended for discussion at an Efficiency Standards Committee hearing on November 28, 2000. The hearing purpose is to obtain public comment on this report and revisions to the Title 24 Building Energy Efficiency Standards (California Code of Regulations, Title 24, Part 6).

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November 17, 2000

# **AB970 Residential Building Energy Efficiency Standards**

## **Volume I**

### **Summary**

#### **Preface**

The proposed AB970 changes for Residential Buildings are documented in three parts. Volume I summarizes the proposed changes. Volume II documents the proposed language changes to the Standards and the ACM Manual. Volume III provides the analysis and impact of the proposed changes.

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## 1. Summary

When the Legislature signed AB 970 into law, it included provisions directing the California Energy Commission to increase the stringency of the energy efficiency standards to the maximum feasible level that is cost effective. The legislation also instructed the commission to complete the process in 120 days.

The Commission held a public meeting to solicit fully developed ideas for increasing the efficiency of the standards, selected measures that targeted cooling electrical energy use, and immediately began the required life cycle cost and impact analyses. The life cycle cost analysis included three different sets of modeling assumptions, multiple measure cost levels and three different energy price scenarios to ensure that all measures chosen are soundly life cycle cost effective. The analysis is documented in Volume III.

A new Package D is proposed with a set of life cycle cost effective measures that vary by climate zone added to those required in the 1998 Standards Package D. The key changes include requirements for duct sealing, low solar gain glass, and attic radiant barriers, all of which are compliance options defined in the 1998 Standards. Thermostatic expansion valves (TXV) on air conditioning equipment is a new measure required in cooling intensive zones. Table 1 in Section 3 documents the proposed changes by climate zone.

An alternative to Package D that does not require field verification by certified Home Energy Rating System (HERS) raters is also proposed. Table 2 in Section 3 shows this alternative.

A limited number of other changes were made to the standards and Alternative Calculation Methods (ACM) Manual to encourage increased energy efficiency, particularly during summer electrical peak periods. These changes are described in Section 3 and the detailed language is documented in Volume II.

The proposed changes are estimated to reduce source energy use of the standards by 14% on a statewide basis. Cooling energy use, the most significant indicator of peak electrical energy use and demand in the residential standards, is reduced by 39%. The resulting changes when fully implemented are estimated to reduce demand 155 megawatts for each years production of new homes. Details of these estimates are documented in Section 4 and in Volume III.

## 2. Background

### A. Legislative Directive

Assembly Bill 970, signed into law on September 6, 2000, was enacted to respond to growth trends in electricity peak demand that have strained the adequacy and reliability of California's electricity system. The purpose of the law is "to provide a balanced response to the electricity problems facing the state," including "making significant new investments in conservation... programs in order to meet the energy needs of the state for the next several years."

The bill provides the following direction to the Energy Commission related to Building Energy Efficiency Standards.

"Public Resources Code 25553. Notwithstanding any other provision of law, on or before 120 days after the effective date of this section or on the earliest feasible date thereafter, the commission shall take the following action:

(b) Adopt and implement updated and cost-effective standards pursuant to Section 25402 to ensure the maximum feasible reductions in wasteful, uneconomic, inefficient or unnecessary consumption of electricity."

The Commission is conducting an expedited rulemaking to consider amendments to the current Standards on an emergency basis within the 120-day period. The proceeding is focused on measures that can be quickly analyzed and justified, and which have a clear and significant impact on peak energy demand. There is not enough time within the 120-day period to consider all potentially desirable Standards changes. Some potentially desirable changes are not feasible to adopt within this 120-day period. Consistent with the AB 970 "on the earliest feasible date" language, investigating and developing some measures will have to be continued to the next update of the Standards.

Staff established the following minimum criteria for measures to be considered as part of the emergency proceeding:

- Changes for which there is a specific idea for how the proposed measure could be incorporated into the Standards;
- Measures for which cost data and the method for calculating energy savings with approved calculation methods was already well-documented; and
- Measures that would not require extensive algorithm changes to be made to the performance standards approved calculation methods.

B. Measures Considered

The Commission considered measures that would address AB 970 peak demand concerns and achieve the maximum feasible energy savings. Preliminary analysis resulted in the conclusion that it was not feasible to adopt a number of these measures in this expedited proceeding. These should be further considered in the next standards update proceeding.

C. Measures Not Feasible to Address in 120 days

Following is the list of measures that were deemed infeasible for this rulemaking and the reasons they were so deemed:

Modifying the internal loads assumptions. Preliminary studies show that the internal loads in residential buildings may be significantly higher than presently assumed. However, these studies have had minimal peer and public review. It is not feasible to make this change in loads assumptions as there is not sufficient time in this proceeding to complete the review and verification.

Requiring ACCA Manual D duct design as part of Alternative Component Package D. Duct design currently is not typical practice for residences, and is done only on a limited basis in some utility and leading edge energy efficient home programs. While extremely cost effective for production homes, staff concluded that the practice was not developed sufficiently for costs to be reasonable for non-production homes. For the emergency proceeding, duct design will continue to be a compliance option. It should be reconsidered for a prescriptive requirement in future updates of the Standards.

Requiring measures when HVAC and ducts are altered in existing buildings, including thermostatic expansion valves (TXVs) and duct sealing when air-conditioning equipment is replaced, and ACCA Manual D duct design and duct sealing when duct systems are being replaced. Although further studies may show these measures are cost effective when completed in conjunction with other building alterations, time did not allow for full investigation of the circumstances under which these improvements would be feasible and cost effective.

Modifying the glazing area used as the basis of the standards. Preliminary studies of standard practice glazing areas indicate the Commission should consider changing its glass area assumptions and its methodology of modeling glass area as an efficiency measure. Recent studies show this to be a particularly significant issue in multi-family buildings. However, it is not feasible to resolve these issues given the time available for this proceeding.



Using low conductance frame fenestration products (non-metal products such as vinyl and wood) as the basis of the standards. Although cost effective, the primary reason low conductance frames were not included as a feature of Package D is that they do not impact peak energy demand to the degree that low solar gain low emissivity (spectrally selective) glazing does. Further, staff could not verify that the fenestration industry could meet the increased demand for low conductance products in the short time leading up to implementation of these standards, nor could they determine the impact such a change would have on manufacturers who do not supply low conductance frame products. Because they are cost effective, low conductance frame products are included as part of an alternative to Package D that eliminates the need for field verification by a HERS rater, and will likely be a choice for performance compliance trade-offs. Low conductance frames should be reconsidered as a basis of the Standards in the next update.

Requiring water heater insulation blankets and heat traps. Research shows that both of these measures are cost effective and result in effectively higher efficiency water heaters. However, the current water heating credit is an important trade-off option, particularly with a more stringent standard.

Raising the minimum mandatory ceiling insulation from R-19 to R-30. This proposal could affect a wide variety of ceiling designs, particularly those designs commonly used for vaulted ceilings in milder climate zones. This change is not feasible since the Commission cannot determine the cost implications on these designs within the time of this emergency proceeding.

Including quality construction protocols as mandatory measures. These protocols are relatively new and have had limited exposure to the construction market. Further investigation is needed to determine what aspects of these protocols are justified for inclusion in the Standards.

Providing a multi-family water heating budget for central water heating systems based on a central water heating system. The current water heating standard is based on the conditioned floor area of each dwelling unit for both single- and multi-family homes. When a central water heater is used, the current calculation method does not account for additional piping losses resulting in the method showing substantial savings for the central water heater. Since piping losses are quite large, this is not an accurate indication of efficiency. The result is that this false benefit is used to trade off measures that save peak cooling energy. However, since the needed analysis to correct the problem and assess the impact on compliance for these buildings cannot be completed within the timeframe of this proceeding, it is not possible to change the water heating calculation method.

Requiring documentation to be submitted to the Commission that would verify that the homeowner received key compliance forms and a home energy manual. Staff considered a change that would improve compliance with this existing requirement. Builders would have submitted the verification by mail or electronically. It was not feasible within the time limits of this emergency proceeding to determine the impact this additional documentation requirement would have on builders.

### 3. Proposed Changes

This section provides information about each of the proposed changes to the residential standards, including Package D requirements, alternate Package D measures, fenestration requirements for additions and alterations, performance compliance, and new compliance options for cool roofs and multi-family duct efficiency improvements.

#### A. Package D

Several changes affect the base prescriptive Package D, which also is the basis for determining the standard design energy budget. Table 1 summarizes proposed Package D changes.

**Table 1 - Summary of Changes to Package D**

Climate Zone	Radiant Barrier	Fenestration U-value	Fenestration SHGC	Duct Sealing*	TXV*
1	--	--	--	REQ	--
2	REQ	0.65	0.40	REQ	REQ
3	--	--	--	REQ	--
4	REQ	0.65	0.40	REQ	--
5	--	--	--	REQ	--
6	--	--	--	REQ	--
7	--	0.65	0.40	REQ	--
8	REQ	0.65	0.40	REQ	REQ
9	REQ	0.65	0.40	REQ	REQ
10	REQ	0.65	0.40	REQ	REQ
11	REQ	0.65	0.40	REQ	REQ
12	REQ	0.65	0.40	REQ	REQ
13	REQ	0.65	0.40	REQ	REQ
14	REQ	0.65	0.40	REQ	REQ
15	REQ	0.65	0.40	REQ	REQ
16	--	--	--	REQ	--

--" means no change from current requirements

\* Duct sealing and thermostatic expansion valve (TXV) requires field verification by a certified HERS rater.

### Radiant Barriers

Radiant barriers will be required in specified climate zones as part of Package D. Radiant barriers are an existing compliance option that reduce solar heat gain to the attic by reducing radiant heat transfer on the inside of the roof, keeping attic temperatures cooler on hot summer days, increasing the effectiveness of attic insulation as well as ducts and reducing the need for space cooling.

Minimum qualifications for radiant barriers will continue to be required including product certification to the Bureau of Home Furnishings (as part of insulation certification) with a product emissivity of 0.05 or less. Full installation requirements are described Section 4.24. of the ACM Approval Manual (see Volume II).

### Fenestration

Low solar gain fenestration products will be required on all orientations in specified climate zones as part of Package D. Fenestration with low solar heat gain directly targets peak summer cooling and is effective at reducing overall cooling energy use.

Product performance is based on NFRC U-value and Solar Heat Gain Coefficient (SHGC) values. A common way to meet the SHGC requirement is expected to be low solar low emissivity glass, also known as spectrally selective glass. In addition to lowering SHGC values, these glass products also have the benefit of lowering the U-values, which is also included in the revised Package D.

### Duct Sealing

Duct sealing will be required in every climate zone as part of Package D. Up to 30 percent of heating and cooling energy can be lost through poorly installed or poorly sealed ducts.

There currently is a compliance option for duct sealing. This compliance option requires installer diagnostic testing and certification plus field verification by a certified HERS rater. These requirements are continued for duct sealing in Package D. Also, the duct sealing compliance option prohibits the use of building cavities as plenums, as well as the use of cloth backed duct tape unless used with mastic and drawbands.

### Thermostatic Expansion Valves (TXVs)

Thermostatic expansion valves (TXVs) will be required for central air conditioners in specified climate zones as part of Package D.

A TXV is a refrigerant metering valve that controls the flow of liquid refrigerant entering the evaporator in response to the superheat of the gas leaving it. Its basic function is to keep the evaporator active without permitting liquid to be returned through the suction line to the compressor.

The performance of air conditioners is strongly dependent on proper refrigerant charge and air flow across the coil, both of which are sensitive to poor installation practices. TXVs mitigate the problems of improper charge and airflow. Compliance credit for TXVs will require field verification by a certified HERS rater. Access is required so that the HERS rater can visually observe the presence of the TXV.

### Additions and Alterations

Residential prescriptive additions of up to 100 square feet and alterations will be required to comply with Package D Solar Heat Gain Coefficient requirements for new fenestration, in addition to meeting a maximum 0.75 U-value. If fenestration is being repaired or replaced, but not in conjunction with a building alteration, it is exempt from the 0.75 U-value and Package D SHGC requirements.

#### B. Package D Alternative

An alternative is proposed to provide prescriptive packages with features that do not require diagnostic testing and field verification by a certified HERS rater. This alternative combination of features was selected to meet the total energy budget of regular package D while also meeting the cooling energy budget to maintain peak electricity savings.

Table 2 shows the alternative features selected including lower fenestration U-values and SHGC values, and higher equipment efficiencies. All other requirements of Package D apply (for example, if a radiant barrier is required in Package D, it is still required with this alternative).

Duct sealing and TXV (when required) can be substituted by installing all of the requirements listed below for the appropriate climate zone:

**Table 2 - Package D Alternative to Duct Sealing and TXV Requirements**

Climate Zone	Fenestration U-value	Fenestration SHGC	Equipment Efficiency
1	0.55	--	90% AFUE
2	0.40	0.35	--
3	0.55	--	--
4	0.40	0.35	--
5	0.55	--	--
6	0.55	--	--
7	0.40	0.35	--
8	0.40	0.35	--
9	0.40	0.35	11 SEER
10	0.40	0.35	11 SEER
11	0.40	0.35	12 SEER
12	0.40	0.35	11 SEER
13	0.40	0.35	12 SEER
14	0.40	0.30	12 SEER
15	0.40	0.30	13 SEER
16	0.55	--	90% AFUE

### C. Compliance Modeling Changes

#### Interior Shading Devices

Credit for all interior shading devices in all compliance approaches will be eliminated. Performance compliance currently allows credit for opaque roller shades and blinds. In 1998, this credit was removed from prescriptive compliance and the roller shade credit was reduced to a level equivalent to blinds. The credit for roller shades was set to sunset on January 1, 2002. Interior shading devices are not a reliable energy conservation measure because their efficiency is highly dependent on occupant behavior and interior shading devices have been especially prone to compliance problems. This change will eliminate compliance credit for both roller shades and mini-blinds.

#### Central Air Conditioner Assumptions

The modeling assumptions for air conditioner system efficiency will be changed to reflect typical performance based on findings of field studies on standard practice air flow, refrigerant charge and fan wattage. The efficiency is also adjusted for outdoor temperature effects based on the typical operating temperatures found in California climate zones. Details of this adjustment can be found in Section 3.8.3 of the ACM Manual (see Volume II).

D. New Compliance Options

Cool Roofs

A new compliance option is established for roofing materials with higher reflectance. Some roof materials or coatings have significantly higher reflectance, reflecting solar gains from the roof, keeping attic temperatures lower and reducing cooling energy use.

A credit equal to the cooling credit for radiant barriers will be available for tile roofs with a solar reflectance of 0.40 or higher and other roofs with a solar reflectance of 0.70 or higher. A minimum emittance of 0.75 or higher is also required.

Effective January 1, 2003, all products qualifying for this credit will be required to meet the Cool Roof Rating Council testing, certification and labeling requirements described in Section 10-113 (see Volume II). Prior to January 1, 2003, the solar reflectance shall be measured in accordance with ASTM E1918-97 or ASTM E903-96. Emittance shall be measured in accordance with ASTM E408-71(1996)e1 or ASTM C1371-98. The solar reflectance and emittance shall be certified by the manufacturer and reported in product literature.

Multi-Family Ducts

Current credits for ACCA Manual D duct design and duct sealing will be expanded to multi-family buildings. These options are presently limited to single-family dwelling units.

E. Mandatory and Procedural Changes

Fenestration Default Table

The glazing descriptors used in the fenestration default table of “uncoated” and “tinted” do not adequately describe the surfaces of all glazing. Some products are coated, but not tinted. Staff is proposing more accurate descriptors for Table 1-E of “clear” and “tinted.”

Ducts

The mandatory duct construction requirements are being changed to eliminate the use of building cavities as ducts and the use of cloth backed rubber adhesive duct tape unless it is used in combination with mastic and drawbands. This disallowance of some duct tape and using building cavities as ducts extends the current criteria for duct credits to the mandatory requirements.

### Field Verification

Current “sampling” procedures require the HERS provider to select homes randomly for third-party verification. A proposed change would give this authority to the HERS rater to avoid delays in completing the necessary field verification.

#### F. Miscellaneous

### Cardinal Orientation Shading Option

The option to have different shading requirements on different orientations for cardinal compliance is removed. When builders use “cardinal” compliance by showing that a building complies in any of the four cardinal orientations, this provision helps to minimize documentation for subdivisions, which will likely have buildings facing any orientation. In the past, builders might use roller shades or mini blinds on the side of the building with the largest area of glass facing west. With the removal of any credit for interior shading devices and with the advances in glazing technologies that allow compliance with low solar heat gain coefficients without the need for interior or exterior shading devices, this compliance option is not needed and will be removed.

### Packages A, B and C Changes

It is staff’s view that Packages A and B are not used for compliance and should be removed. To avoid confusion, Packages C and D will not be renamed at this time.

Since the new and updated features of Package D are cost effective, they should be included in Package C requirements where it will increase the efficiency of that package. See updates in Tables 1Z-1 through 1-Z16 in Volume II.

## **4. Impact**

#### A. Energy and Demand Savings

Table 3 shows the savings achieved by the proposed packages compared with the 1998 Standards requirements in the 1761 square foot prototype home in each climate zone. The source energy savings range from 3% to 23% of the estimated 1998 Standards consumption. The largest savings are achieved by cooling oriented measures in the zones with the highest cooling loads. Heating energy increases slightly in 3 zones because of the

requirement for low solar gain glass which reduces winter as well as summer solar gain.

**Table 3 – Energy and Demand Savings per Home**

Climate Zone	Source kBtu/ft <sup>2</sup>				Energy and Demand		
	Heating	Cooling	Total	%	Therms	kWh	Peak kW
1	1.7	0.0	1.7	5%	30		
2	-0.9	5.5	4.6	11%	-15	945	1.8
3	1.1	0.1	1.3	4%	20		
4	-0.3	4.6	4.3	12%	-5	791	1.5
5	1.1	0.1	1.2	4%	19		
6	0.4	0.2	0.7	3%	7		
7	-0.5	3.1	2.7	11%	-8	541	1.1
8	0.4	3.5	3.9	14%	6	607	1.1
9	0.6	5.8	6.3	18%	10	990	1.7
10	0.8	7.9	8.7	20%	14	1352	1.9
11	0.7	6.3	7.0	14%	12	1091	1.7
12	0.3	4.6	4.9	11%	5	783	1.5
13	0.3	7.9	8.1	16%	5	1355	1.6
14	0.4	8.2	8.6	15%	6	1414	2.4
15	0.3	15.9	16.2	23%	5	2727	2.4
16	4.5	0.4	4.9	8%	80		
average	0.7	4.6	5.3	12%	12	1145	1.7

Natural gas savings is greatest in the coldest climates (zone 1 and 16) and averages 12 therms per house. Electricity and peak demand savings are shown for climate zones where air conditioners are typically installed in new houses. The kWh savings range from 541 kWh in Zone 7 (San Diego) to 2727 kWh in Zone 15 (Palm Springs).

Electrical peak demand savings is estimated based on the on a minimum efficiency air conditioner sized according to standard industry calculations with the effects of duct leakage and radiant barriers accounted for. The calculated demand savings assume that the builders do not reduce the size of air conditioners and are reduced 35%. This reduction is based on data that shows that a significant number of home occupants will operate their oversized air conditioners so that they run continuously on peak regardless of actual load. The resulting demand savings range from 1.1 kW on the Southern California Coast (Zones 7 and 8) to 2.4 kW in the Southern California Desert (zones 14 and 15).

Table 4 shows statewide energy and demand savings for the prototype house weighted by construction starts in each climate zone. The estimated number of single family homes built in each zone (SF Houses/year) is based on the Construction Industry Research Board (CIRB) data for 1999. Approximately 40% of



statewide electrical energy and demand savings are achieved in Climate Zones 10 (Riverside) and 12 (Sacramento) where there are both a large number of new houses built and significant cooling savings due to the proposed packages. Overall statewide savings are 844,568 therms of natural gas, 99,731 megawatt hours of electricity and 155 megawatts of demand for each year's production of new homes.

**Table 4 – Energy and Demand Savings Statewide**

Climate Zone	SF Houses/year		Energy and Demand		
	CIRB %	Houses	Therms	mWh	Peak mW
1	0%	349	10319		
2	3%	3597	-54475	3400	7
3	6%	5995	119296		
4	7%	7532	-41117	5961	11
5	1%	1417	26950		
6	4%	4807	35553		
7	8%	8404	-71036	4546	10
8	6%	6246	38495	3790	7
9	6%	6605	68629	6537	11
10	15%	16448	231721	22231	31
11	5%	5657	67743	6174	10
12	19%	21070	115022	16502	31
13	8%	8960	41023	12139	14
14	5%	5417	33390	7662	13
15	4%	3957	20903	10789	9
16	2%	2540	202153		
Total		109000	844568	99731	155

Statewide savings weighted by starts	5.8	skBtu/ft <sup>2</sup>
Percent saved weighted by starts	14%	

The calculation method used to determine the 155 megawatt savings estimate is consistent with engineering methods used for determining the cooling needs for buildings and has been reduced to account for expectations of typical occupant behavior with oversized cooling systems.

Uncertainties that could cause these savings to be lower are:

- Number of air conditioners actually installed,
- Actual average glass orientation may be better,
- Installation of non-cooling measures in place of cooling measures in performance compliance.

Uncertainties that could cause these savings to be higher are:

- Typical houses may be larger than used in this analysis,

- Typical glass areas may be larger than used in this analysis,
- Actual average glass orientation may be worse.

The expected range of uncertainty is expected to be smaller than 50 megawatts resulting in high confidence that these standards should achieve savings greater than 105 megawatts and reasonable potential to save greater than 155 megawatts.

#### B. Cost of Proposed Changes

Table 5 shows a conservative estimate of the cost of the proposed prescriptive Package D measures in the prototype house in each climate zone. The proposed package measures would allow the builder to downsize the air conditioner compared to the size required by the 98 Standards and the resulting cost to the homeowner (estimated at \$400 per ton) are shown in the A/C Savings column. The Net 1<sup>st</sup> Cost column shows the cost increase to the homeowner in each climate zone. The Statewide Average Net Cost of \$339 per house is average of net 1<sup>st</sup> costs, weighted by the percentage of building starts in each climate zone.

**Table 5 – Cost of Proposed Changes per Home**

Climate Zone	Measure Cost	A/C Savings	Net 1st Cost	% of Starts
1	\$300		\$300	0.3%
2	\$1,100	\$(747)	\$353	3.3%
3	\$300		\$300	5.5%
4	\$950	\$(583)	\$367	6.9%
5	\$300		\$300	1.3%
6	\$300		\$300	4.4%
7	\$529	\$(433)	\$96	7.7%
8	\$1,100	\$(456)	\$644	5.7%
9	\$1,100	\$(724)	\$376	6.1%
10	\$1,100	\$(806)	\$294	15.1%
11	\$1,100	\$(739)	\$361	5.2%
12	\$1,100	\$(629)	\$471	19.3%
13	\$1,100	\$(667)	\$433	8.2%
14	\$1,100	\$(1,058)	\$42	5.0%
15	\$1,100	\$(1,057)	\$43	3.6%
16	\$300		\$300	2.3%
Statewide Average Net Cost per House			\$339	